237994

October 24, 2011

From: Paul L. Kahn, OSC

To: Kevin Shaver, RM

Subj: Potential Fire Hazard with Varnish Material

Attached please find a 1913 Underwriters report on possible fire hazards associated with manufacturing varnish. Please review this document so that when we remove the contents of the varnish tank and the varnish tanks (Bldg. 7) we can take the necessary precautions. I have highlighted some of the more relevant areas of consideration.

When it comes time to remove the varnish from the tank on the roof please have your H & S person perform a hazard analysis of the technique we have selected to remove and bulk the varnish.

NEW YORK, SEPTEMBER 6, 1913.

VARNISH FACTORIES.

Proper Building Construction—Materials and Manufacturing Processes Described—Fire Hazards Pointed Out.

By F. E. Roberts. Inspector, Xorurich Union, Toronto, Canada.

Some kind of a transparent preservative material or varnish, applied to a painting, has apparently been known for centuries. Paintings from Herculaneum and Pompeii have seen unearthed in which the colors appear perfectly bright. The varnish or preservative material was a preparation of wax. Real varnish, however, dates from the discovery of the art of lacquering, in Japan, during the eighth century A. n. Japan lacquer is essentially the juice or sap of a small tree, a natural varnish, and, as prepared and used by the Japanese, gives a lustrous and durable coating, probably not equaled by any other kind of varnish today.

Varnishes may be divided into two classes—oleo-resinous and spirit varnishes. The first consists of a drying oil, driers, resins, turpentine and usually benzene. The second consists of resins dissolved in some volatile solvent. Shellac varnish, often called simply "shellac," is the common representative of the second class. Oleo-resinous varnish is the more important class and the kind most generally meant by the term "varnish" when used without qualification.

MANUFACTURE OF OLEO-RESINOUS VARNISH.

We often see old buildings, as old dwellings which should be torn down, converted into "light manufacturing" premises, a purpose for which they are totally unsuited. Frequently there are several occupancies of this nature under one roof—a veritable hive of industry. It is not an uncommon occurrence, however, for the bees to be smoked out. "Light" manufacturing is sometimes a very apt term in more senses than one. It is a pleasing feature of varnish making that any old shack cannot be converted into a varnish factory. On the contrary, special buildings have to be erected, used for that purpose only, and wandering bees must seek hives elsewhere.

I. Melting and Varnish Boiling BUILDING.

This building should be of fire resistive construction throughout, having but one story and no basement, a cement floor, fiat roof with standard skylights and no exposing windows. These buildings are frequently found with wooden roofs and nonstandard skylights, and occasionally with windows.

A succession of chimney stacks, or one continuous stack, for the furnaces generally cover one entire side of the building.

Sometimes this stack is located in the centre of the building with the furnaces on opposite sides.

The furnaces are circular in form, underground, with an underground draft, the mouth being just above the floor. In operation the surface of the burning fuel (coke) is about level with the floor. In one form the stack for the furnace is built out into the room to form a hood (Fig. 1), the very wide flue being directly over the furnace. In another, the hood is thrown out from the face of the stack with a large opening into the flue. One form has a separate "vapor flue" at the back, joining the main flue (which latter is directly over the furnace), part way up. In either case the varnish pot when on the fire sets entirely within the "oven" formed by hood and dividing brick walls from other ovens (Fig. 2). Generally in addition there is a metal hood attached to the oven, which can be let down when the pot is drawn off the fire.

REDUCING BUILDING.

This is usually a shed, with one side open, or with doors only on one side. The description of boiling building should apply to this, omitting the stack, ovens and furnaces, and does apply in a good factory, except that fireproof walls are still more rare. A fireproof roof is not so important, though desirable. Where the building is a brick or concrete shed with one side open (Fig. 3), giving all the light required, a light, all metal roof is sufficient. It should be well detached from the boiling building, but sometimes adjoins one end. If any attention is paid to proper construction, there will be no communication between these buildings.

COOLING, SETTLING AND FILTERING BUILDING.

This is a small structure which may adjoin the reducing building, without communication. The same general description for the other buildings applies to this one. The roof should be of fireproof or first class construction. In some factories this building is omitted entirely.

VARNISH STORAGE BUILDING.

This should be a detached one-story building of fire resistive construction, with no basement, having a cement floor, and with blank walls against all exposures. Variations from this type will he found, but in a good establishment it is at least a first class building, having one story, with no basement, and with exposures fairly well protected.

In addition to the above there may also be buildings and sheds for storage of oils, gums, supplies and barrels, and possibly oil tanks. Benzene is generally kept in underground tanks, and in the best establishments turpentine and turpentine substitutes receive like treatment. While in some special cases it may be deemed allowable to store volatile liquids in tanks above ground, the safer way, applicable to all cases, is storage in underground tanks.

MATERIALS.

The principal oil employed is linseed, though Tung or Chinese wood oil has been used to some extent for several years. At the present time, owing probably to the very high prices of linseed oil. it is largely employed, and is said to be a good varnish oil. There is another oil on the market, expressed from the Soya bean (native of Japan and Manchuria). Driers are some of the solid substances mentioned under paint factories, and the turpentine substitute is that described as made by distilling pine needles, young twigs and fresh pine wood.

While there is no reason to suppose that linseed oil is purposely adulterated with water by any indirect methods as mentioned under paint factories, yet without such methods it sometimes contains an appreciable amount of water. Water is generally our friend, hut in this case it is our enemy, for such oil is liable to foam excessively when heated and "boil over" with a fire as the result.

The resins used are generally called gums in the trade, though properly speaking gums arc more or less soluble in water, while resins used in varnish making are insoluble. The principal resins are copal of several varieties, kauri, dammar, sandarac, Zanzibar, elemi and rosin. With the exception of rosin all arc products of Africa. South America, New Zealand, East Indies, Philippine Islands and other islands of a tropical or semi-tropical climate. Rosin comes principally from the southern United States. Amber, which may be used in some expensive varnishes, is found on the shores of the Baltic in Germany.

These resins occur as "fossil resins" buried under more or less earth, as exudations from living trees, and some varieties in both forms, the fossil resins being of higher quality. Copal and kauri form the principal ingredients of any resin mixture for good varnishes, while rosin is the chief resin for cheap varnishes.

PROCESSES.

There is little machinery required, being confined entirely to pumps and (liter presses or separators, with possibly a washing drum for cleaning filter cloths with benzene. The utensils are of a very simple nature.

The process of making varnish may be divided into four parts: melting or "running" the resins; addition of oil and driers and boiling the mixture; reducing or thinning with turpentine and benzene; cooling, filtering and "ageing" in closed tanks.

The pots (Fig. 4) in which the resins are melted and varnish boiled are of copper, cylindrical in shape, about 40 inches in diameter and 36 inches high, having a capacity of about 150 imperial gallons. The pot rests on iron carriages on wheels, so they can be drawn on and off the fire and transferred to the reducing shed for thinning. Each pot is fitted with a thermometer, an exceedingly necessary feature. There is also a cover with an opening in the top to which can be attached a pipe leading to the "vapor flue" if one is provided: otherwise it is left open. The covers are used only during the "running" of the resin.

The resins have to be heated beyond their melting point, in fact to the point of partial decomposition, in order to be soluble in the oil. This of course produces a vapor which is inflammable. The oil is also heated before being added to the melted resins, sometimes in a fixed iron cauldron, fire heated, similar to those in common use for "trying out" fats. The oil reaches a temperature of perhaps 250 degrees. Driers are added during the process of boiling the varnish or they may be contained in the oil previously treated. The mixture of resins and oil forms only half or even less of the capacity of the pot.

THE TEMPERATURE EMPLOYED IX MAKING VARNISH

depends on the resins used and also on what each varnish maker may deem the proper temperature for the varnish he is making. Probably 60 degrees is about the high mark. When the varnish maker considers the mixture is sufficiently cooked, the pot is allowed to cool down preparatory to thinning. The whole process of making varnish, including the thinning, can be readily completed within working hours.

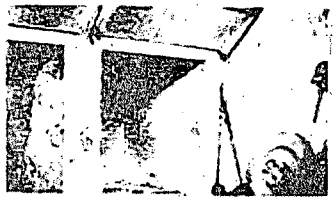
Although the mixture is cooled down before thinning it is not exactly cold when ready, for the thinning may he done while the mixture holds at a temperature of 100 degrees. It is easy to understand, therefore, that copious fumes are given off when the turpentine and benzene are added, even when this is done slowly, with vigorous stirring, and the reducing shed should be so located or arranged that the fumes cannot travel to the furnace fires. In one method of thinning the turpentine and benzene are pumped from underground tanks to graduated cylinders on the wall only as required for use. From these cylinders the liquid flows slowly by piping, sometimes ending with a rose, to the varnish pots.

In one variation a supply of about two barrels is pumped to elevated tanks outside the building from which it flows to graduated cylinders. The stock tanks containing turpentine may be located at some distance and elevated, from which the flow is directly by gravity to the building or just outside of it. Measuring cylinders being dispensed with turpentine and benzene may be brought in from an outside supply in containers as required—or a barrel or more of turpentine and benzene brought into the building and contents removed by a hand pump to containers for thinning. The first method is certainly the best from a fire point of view.

THE AMOU'NT OF THINNING MATERIAL USED

or its composition, depends on the kind of varnish being made and above all on the price. For an average varnish probably the proportions of resin and oil mixture and thinners will be about 60 per cent, and 40 per cent, and the thinner perhaps two-thirds turpentine or turpentine substitute and one-third benzene. For a cheap furniture varnish the thinner may consist in part of something resembling turpentine, but it is tolerably certain the varnish will contain as much benzene as it can stand up under and still be a varnish.

After the thinning the varnish is handled entirely by pumps.



Sometimes when it is thought to be cold the varnish is pumped from pots in reducing building, directly to storage building. Generally, however, the varnish is pumped into cooling and settling tanks in an adjoining building, afterwards pumped through a filter press to the storage tanks in a building preferably detached. The filter press is the same type used in color manufacture, only in this case the liquid is the product and the sediment the waste. A separator may be used, this being a centrifugal machine similar to a cream separator.

An objectionable variation is to have the settling tanks, filtering press, pumps and storage tanks all in one building. Varnish is very likely to be hot, with accompanying fumes when pumped into settling tank, and there should be no mechanical process carried on in storage building, nor anything but cooled varnish pumped into it. The tanks in storage building are closed and good varnish receives a period of "ageing." which may be a year or even more. Cheap varnish requires no extended period of "ageing." It is probably incapable of much improvement by that method.

JAPANS.

The process of making the ordinary black "dipping" Japan is essentially the same as making varnish. Asphaltum and coal tar pitch are the gums and the thinner is turpentine or benzene, depending directly on the price of the Japan. Ordinary open iron cauldrons are used on wheeled carriages as in making varnish. No filtering or "ageing" is required. Stored in tanks similar to varnish. The process is not so exacting *s varnish making, and requires less heat.

HAZARDS.

The principal hazards of resin melting and varnish boiling consist of the ignition of vapors, boiling over and overheating. The first danger is more apparent in the resin melting, for the vapors are abundant and very inflammable. If they come in contact with furnace fire, through a "back draught" or any other cause, a fire is the result. With the wide flue and good draught usual in varnish factories, fires are not numerous.

Both the resins and mixture of resins and oil are liable to foam excessively and "boil over." Presence of water increases this danger. It is said after the resins are thoroughly incorporated with the oil the danger is much less during subsequent heating. The pots are carefully watched and any tendency to excessive foaming allayed by drawing off the fire and "beating down" the foam.

Possibly there is not a very wide margin between the heat liable to he used and the temperature of ignition of varnish or vapor arising from the same. Whatever the reason may be the state of the thermometer is an object of the utmost solicitude on the part of the varnish maker, and the danger would appear to be an overheating of a portion of the mixture, with a consequent "caking on" at the bottom of vessel rather than the overheating of the entire mass. As the contents of the pot are stirred frequently this is not liable to occur. In fact the whole process is one of care. Varnish pots on the fire are not left to run themselves.

VARNISH MAKING IS A TRADE

and one that requires skill and experience, especially up to the thinning stage. Skilled workmen are therefore employed and under their care the danger of beating a highly inflammable mixture is reduced to a minimum. Varnish fires in the gum melting and varnish boiling building are not so numerous as may be thought, and it is not impossible to extinguish all such fires at

their inception. Where not extinguished in a properly constructed and located building, the loss should be no greater than the contents of one varnish pot, possibly including the vessel itself.

Water is of no use in extinguishing a fire in a varnish pot. Exclusion of the air is the only remedy. This is best accomplished by the cover, aided by wet blankets. Sand is useful for preventing spread of burning oil and smothering the furnace fire. The liability of a larger loss than one pot of varnish is due to the fact that the pot may be withdrawn from under the hood in an unsuccessful attempt to extinguish a fire. If there is a wooden roof, it may be ignited, and other pots of varnish may also be ignited. It is, therefore, apparent why there should be a fireproof roof, and also why there should be no storage whatever in the building. One or more oil tanks are sometimes found. This is certainly a defect.

With a fireproof building, well detached and without storage, the chance of a large loss in the building itself or loss by exposure to other buildings is small.

is simply that of the fumes igniting at some fire or spark. While the heat of varnish mixture is sufficient to produce copious fumes, it is not sufficient to ignite the fumes. In most instances ignition is caused by unsafe location of the reducing building in reference to the furnace fires of the boiling building. There have been rare cases where there was no fire which could have caused ignition. Probably there was a spark on bottom of kettle. The fumes in a still air would simply overflow from the pot like water, fall down, meet the spark and ignite. With copper pot and coke fires this danger is not imminent. However, one varnish maker claims he looks after this hazard before thinning.

Benzene vapor will travel a considerable distance, ignite from open flames or fire, and flash back to the main supply. This is said to have occurred over distances of from 33 to 40 feet, depending upon the state of the atmosphere and the direction of the air currents. While turpentine vapor is not so insidious, it would probably not be a very safe operation to thin with turpentine within twenty feet of a fire.

If the reducing shed faces the doors of the boiling building, or any opening, it should be 45 to 50 feet from any lire, unless some effective method of ventilation is adopted to carry off the fumes. In one case the reducing shed faces the end of the boiling building

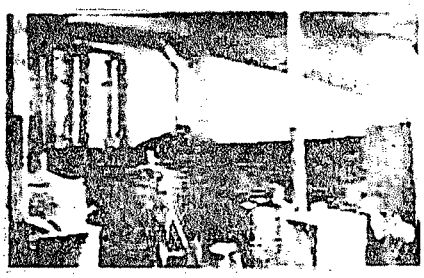


Fig. 3.—REDUCING BUILDING WITH VENTILATING SYSTEM.

which has a door that may be open. There is a distance of *20* feet between the buildings. Over each pot where thinning is done there is a hood connected with a vapor duct extending' along the back of the building, with a suction fan on the outside. There is also a pit, covered by a grating at the front, to which the duct is brought down at one end.

THE THEORY IS

that any of the heavy fumes which may escape from being drawn up the hood, will collect in the pit and rind their way out by way of the extension of the vapor duct. In practice it seems to work perfectly and very little odor is perceptible outside of the shed.

In another factory the front of boiling building faces the solid back of reducing building with a space of from 15 to 20 feet between them, which is satisfactory.

Where the reducing shed adjoins the boiling building at one end. even with no communication between them and the doors of both facing the same way, the arrangement cannot be considered as satisfactory. While any fumes would have to "turn the corner.'" so to speak, to get at the furnace fires, yet there is

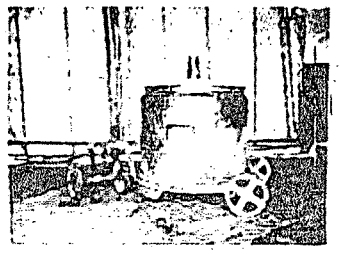


FIG. 4.—VARNISH POT.

a possibility of their doing so. It may be remarked that no dependence can be placed on doors of boiling building being closed, or fires being out. When thinning is going on, however the buildings are located. If pumps are in the building they may be of the rotary type requiring power. If electric power is used no motor or connecting wires should be installed here. They should be placed in a small addition with a solid brick wall separating, and with no opening except shaft hole.

AN APPROVED SYSTEM OF ELECTRIC LIGHTING

is not objectionable in gum melting and varnish boiling building, but if light is required in the reducing shed it should be only the best system possible of electric lighting for places subject to combustible vapors. This would mean conduit wiring, and fixed vapor-proof bulbs, near the ceiling, light turned on from outside. Heat is not required in boiling building and generally reducing shed is too open to allow of it. If heating is desired only well installed steam or hot water from an outside source should be allowed.

The operations of cooling, pumping and filtering present no especial danger with an approved system of electric lighting, steam or hot water heating. The building or section should be separated from reducing shed by solid fire wall. While a motor may sometimes be found here, it would be better outside located the same manner as recommended for reducing building. A separator for filtering varnish is a very rapid running piece of machinery. It will have at least the frictional dangers always present in such machines, and the filter press is preferable from a tire hazard point of view.

THERE IS AN OILY RAG HAZARDI

in discarded filter cloths, and in addition, where apparently expensive filter cloths are used, there is the hazard of washing in an oscillating drum of benzene. Filter cloths that are not too expensive to be burned up every night are much to be preferred.

The reason why the varnish storage building should be of fireproof construction, detached and free as possible from exposure, is mainly because it is here that very large values in proportion to other buildings of plant are assembled. It is necessarily heated either by steam or hot water, preferably from an outside boiler house. If boiler house adjoins, it should be cut off by a solid wall, with no opening by fire door or otherwise. The varnish storage should be protected not only from fire dangers originating in boiler room, but also from any fumes finding their way to furnace fires. The advisability of a one story building with cement floor, no basement, and cement platforms for varnish tanks, is apparent. It can also be seen that the presence of settling and cooling tanks of hot varnish, and the process of filtering or bringing the pots of varnish, possibly hot, inside of the building for transference to tanks, are objectionable. If a power pump is required it should be steam.

While there is probably no exact chemical union between the thinning material for varnish and the resin oil combination, ye; at ordinary temperatures, even with a cheap varnish, there is probably not so much vapor given off as would be evolved from the thinners alone, and in a good varnish fumes are not very extensive. When a varnish is hot, however, the combination, if any, is broken up and fumes more or less extensive are given off, depending directly on the kind and amount of thinners used.

FIRE PROTECTION.

The gum melting and varnish boiling building should contain six buckets of sand with auxiliary supply of sand in a bin or barrel. There should also be a barrel of water containing woolen blankets or bagging. The reducing building should be provided with similar protection, and the cooling and filtering sections should lie provided with pails of sand.